HIV Modelling Consortium

Work Package 11: Investigating HIV Incidence Declines
Meeting Report

Background

The 2012 UNAIDS Report on the Global AIDS Epidemic reported large declines in HIV incidence in a number of countries, both in Africa and globally, over the last decade. While these estimates have been promoted as evidence for the effectiveness of the international response to HIV/AIDS, in many settings these observed reductions were not coupled with the large changes in risk behaviour or large program efforts or scale up of ART, which may have been anticipated *a priori*. As such, the HIV Modelling Consortium were asked by the Steering Committee to explore potential mechanisms that (1) could reconcile the apparent discrepancy between these, or (2) could potentially lead to spurious or exaggerated estimates of declines in HIV incidence.

The Secretariat, in conjunction with external collaborators identified existing research and developed and conducted preliminary investigation into several hypotheses. This meeting aimed to review this work and generate further hypotheses, research agendas and recommendations for how to interpret and communicate these trends.

The HIV Modelling Consortium

The HIV Modelling Consortium aims to improve scientific support for decision making through the co-ordination of a wide-range of research activities in mathematical modelling of the HIV epidemic. This project is currently funded by the Bill & Melinda Gates Foundation through a grant to Imperial College London.

The Consortium's key objectives are to:

1. Identify questions that demand mathematical modelling input and identifying new modelling results that may require further validation.
2. Facilitate sharing of information; modelling techniques, data and expertise between research groups.
3. Provide a forum for rigorous review of new mathematical modelling research and tools.
4. Provide funding through sub-contracts to commission research to address those needs.

A Steering Committee of leaders in HIV programme and policy directs the focus of the work of the consortium. Further information on the HIV Modelling Consortium is available in a standard briefing document and information about other work packages undertaken by the HIV Modelling Consortium is available at the website www.hivmodelling.org.

Aim of the meeting

Meeting aim: To review and examine reports of HIV incidence declines at a country level

Following presentations on current work in the field the group worked to answer the following questions:

1a) Can we be confident that estimated incidence declines are real?

1b) What might explain lack of association between estimated incidence and individuals' risk of HIV infection?

2) How should this affect our interpretation of the UNAIDS estimates?

3) What development of methods is possible to increase confidence?

This meeting has been held at the hypothesis gathering stage in order to identify to what extent the reported declines in HIV incidence can be accounted for and whether there may other factors contributing to these observations. The ultimate goal of the meeting is to identify future avenues for research where certain factors may appear to have a bigger impact on changing incidence. This may be behaviour change in relation to successful program interventions or an artifact of changing bias in the data used to calculate the estimates or the method of calculating the estimates. Following this meeting the Secretariat, in conjunction with the Steering Committee, will identify possible work streams for further work.

Why we need to better understand the UNAIDS incidence estimates

UNAIDS have a requirement to report on the status of the HIV epidemic for the United Nations Political declarations on HIV/AIDS and Millennium Development Goals. In order to provide estimates on incidence and prevalence at a country level UNAIDS use the *Spectrum and Estimation and Projection Package (EPP)* suite of models developed by Futures Institute. The Spectrum and EPP programs are used to estimate key HIV indicators based on HIV surveillance and surveys, programme statistics and epidemic patterns. Each year UNAIDS publish the latest estimates for these key indicators in their Global Report. The 2012 report estimated that 25 countries experienced a greater than 50% decline in HIV incidence between 2001 and 2011 (Table 1), which is very substantial. While these figures may appear very reassuring it is important to recognize that incidence estimation is inherently difficult in HIV and reporting of these figures may require more explanation of the uncertainty.

Table 1: Countries reporting a >50% decline in incidence between 2001 and 2011 / 2012

	Countries where HIV Incidence Declined Greater than 50% in 15 - 49 year olds	
	2001 – 2011 (2012 UNAIDS Report)	**2001 – 2012 (2013 UNAIDS Report)**
1	Bahamas	Belize
2	Barbados	Botswana
3	Belize	Cambodia
4	Botswana	Cote d'Ivoire
5	Burkina Faso	Djibouti
6	Cambodia	Dominican Republic
7	Central African Republic*	Eritrea
8	Djibouti	Ethiopia
9	Dominican Republic	Gabon
10	Ethiopia	Ghana
11	Gabon	India
12	Ghana	Jamaica
13	Haiti	Liberia
14	India	Malawi
15	Malawi	Myanmar
16	Myanmar	Namibia
17	Namibia	Nepal
18	Nepal	Niger

19	Papua New Guinea	Nigeria
20	Rwanda	Papua New Guinea
21	Suriname	Sao Tome and Principe
22	Thailand	Senegal
23	Togo	Thailand
24	Zambia	Togo
25	Zimbabwe	Ukraine
26		Zambia

Key

	2001 - 2011 only
	2001 - 2011 and 2001 - 2012
	2001 - 2012 only

*Not in latest report, as they did not submit any estimates due to ongoing conflict in the country. Between successive UNAIDS report the determination of a decline for a country can change.

Hypotheses for reasons for potential poor inference about incidence from HIV prevalence data

To calculate incidence estimates it is necessary to rely on a number of different data sources, which inherently have biases from collection and sampling, in addition to possible issues with the estimation method selected by countries or, until know, unrecognized weaknesses of the model itself.

Data for HIV prevalence, which is used to estimate HIV incidence in *Spectrum*, is collected from a number of sources: Demographic and Health Surveys (DHS), antenatal clinics (ANC) and Demographic Surveillance Systems (DSS). Since 2001 Measure DHS has included a voluntary and anonymous HIV testing protocol that, while not providing results, encourages individuals to attend VCTs for testing and it is hypothesised that poor inference about incidence from prevalence data may result from more individuals becoming aware of their status and therefore refusing these HIV tests in subsequent surveys (as they may not want to disclose their positive status or have an unnecessary test if they already know the outcome). This would create a selection bias if positive individuals were self-selecting themselves out of the sample. This could therefore contribute to recent declines in HIV incidence.

Mark McGovern presented a summary of literature on rates of refusal for HIV tests in the DHS and DSS. He reported that most individuals who are asked to participate in a DHS will accept, but to varying degrees in different countries people do not give consent for an HIV test. For example, refusal rates to HIV tests are ~5% in Malawi whereas in Zimbabwe they have been as high as 25%, and in general the consent rates are increasing with each survey. A study in Malawi by Kranzer *et al.* (2008) found that the primary reason for refusal in men was 'to have more time to think' and in women it was predominantly due to fear of a positive result. Refusal because individuals already knew their status was not considered one the major causes of refusal. Further studies (Reiners & Eaton, 2009; Floyd *et al.* 2013), however, have demonstrated that there may be a relationship between prior knowledge of infection status and test refusal. In summary, while there is evidence that a selection bias may exist, in most countries the refusal rates are too low for knowledge of infection status to be an important factor.

Kim Powers presented results from a recent modelling analysis that looked at whether increasing awareness of HIV status lead to increasing non-differential patient refusal for HIV+ve individuals compared

to HIV-ve individuals. Powers utilized an heuristic model of bias in DHS surveys, which is based on observed HIV prevalence in DHS, the prior testing rate, the refusal rate and assumptions about the relation between prior knowledge of one's HIV status and consent for testing, to conduct the analysis. Using this methodology Powers inferred what the 'true' HIV prevalence would be in comparison to DHS prevalence if these biases were all operating.

The study reviewed four different bias metrics:

1. Relative bias: DHS vs. true overall prevalence at latest DHS and previous DHS
2. Absolute bias: number of percentage points between DHS-estimated change in prevalence vs. true change in prevalence over time
3. Direction of bias: DHS-estimated change in prevalence vs. true change over time
4. Relative bias by direction of bias: DHS vs. true change in prevalence

The exercise demonstrated that in many African countries the bias in DHS surveys is changing over time, but that the direction and magnitude varies greatly between each country resulting in either possible over or under-estimation of incidence. In the model a greater number of countries did overestimate the decline in HIV incidence, but this was often by a small percentage (e.g. 1.01 times bigger than 'true' decline in Burkina Faso), but on occasion was high at about 4 percentage points (183.2 times bigger than 'true' decline in Lesotho).

In addition to biases in DHS, ANC surveillance methods may also be prone to selection bias. Simultaneous changes in the age distributions of pregnant women and of HIV-infected persons, combined with changes in fertility among HIV-infected women with increasing coverage of antiretroviral therapy (ART), may be producing HIV prevalence trends that are inconsistent with trends in the overall population. **Kim Powers** presented some preliminary work, which aims to review whether there might be ART-associated changes in fertility (whereby women going on ART have changing fertility) and age distribution of HIV+ve women (as older women are less fertile than younger women), which may create a bias in the ANC estimated HIV prevalence change. Kim Powers also investigated whether combining subnational epidemic trends influence the country trend. As there is often great variation in the trajectory of subnational trends the amalgamated overall epidemic curve can be affected. It was agreed by all meeting attendees that this is a clear area for future work.

Jeff Eaton provided results from a recent modelling analysis in which he assessed HIV prevalence in 15 – 49 year olds in serial DHS against EPP curves to ascertain if there were any large discrepancies in reporting. While it may not be very surprising if there were differences between the two (due to DHS being only one data source and EPP using multiple and including DHS as only one clinic site,) it could still provide a useful analysis to see if there are circumstances where the differences are very large. The DHS data were plotted for each country (and by region) with serial surveys and the EPP curve was overlaid. The results showed that EPP in many cases does fit the DHS surveys very closely; but that overall it is possible that EPP has been systematically overestimating declines in prevalence in southern African epidemics in recent years. It was commented that in some scenarios it is likely that it may not be possible for the EPP curve to fit all of the points exactly as it may be limited in the curve that it is able to create.

Further work from **Jeff Eaton** looked at potential biases in recent HIV incidence estimates that may arise from calculations or model adjustments for ART uptake. As many clinics report the number of people on ART for the last quarter (people on ART = number already on treatment + number of new people on treatment – people lost to care), it is very difficult to account for the number of people who are lost to care and therefore a higher estimate of those being treated is usually reported. Unpublished reports have estimated clinics over report people on ART by as much as 36% in sSA. If the on ART population is over reported, this leads to greater bias in incidence: around 10% to 40% smaller incidence declines. In addition, in African countries people disproportionately go on ART at lower CD4 cell counts and therefore there are more people who are alive because of ART than if you assume people start ART at any time point or at higher CD4 cell counts. Accounting for late ART at initiation results in lower incidence estimates than during early scale-up, which

would decrease as program reaches scale. This effect may lead to slightly lower current incidence, which would translate to slightly greater incidence declines.

Factors disconnecting behaviours from prevalence trends

Ecological studies have often failed to find an association between changes in sexual risk behaviour and prevalence of HIV and STIs. This may due to reporting biases for sexual behaviour, as people may not want to disclose certain details or may over report behaviours because of social desirability. Limitations in reliability and consistency of methods used to collect and analyse data on sexual behaviour could explain why in some countries there are reported changes in the HIV epidemic, which are not linked to sexual behaviour.

In a number of countries in sub-Saharan Africa, e.g. Zimbabwe, Kenya and Malawi, there is evidence of behaviour change, such as reductions in the number of sexual partners, increased condom use and delay in sexual debut. **Laith Abu Raddad** presented a recent modelling analysis that reviewed changes in sexual behaviour across countries in sub-Saharan Africa. The model estimated a 69% reduction in sexual risk behaviours in most countries, which occurred on average in the late 1990s for 8 years. In most countries these reductions in sexual risk behaviour did appear to couple changes in the epidemic at a national level during the late 1990s. For example, in Kenya it was demonstrated that these changes in behaviour were followed by a decline in AIDS related deaths. For six countries in the investigation (Angola, Chad, Nigeria, Zambia, South Africa and Swaziland), however, the trend in HIV prevalence was not found to be consistent with a large in rapid transition in sexual risk behaviour.

Where countries did exhibit both a decline in risk behaviour and AIDS related mortality further investigation is required at a country level to assess whether this is a consequence of programs or another factor. It was considered that growing awareness of HIV in the general population, and individuals witnessing relatives suffer from the infection, could itself cause a change in behaviour that is not directly a consequence of interventions.

Tim Hallett raised the discussion of natural dynamics of the epidemic, which could explain declines in incidence and prevalence without behaviour change. For example if there were no real changes in risk behaviour it could still be possible that incidence is declining as infection and illness is occurring within the high risk groups, and as these groups become saturated and individuals die, the overall group diminishes and there are fewer people to pass on the infection. However, this risk group can be replaced and the rate of replacement of this risk group is important to understand how the infection can persist within a population, in addition to understanding the mixing patterns between risk groups. The difficulty in attributing the role of natural dynamics of the epidemic to reductions in incidence lies in our understanding of the heterogeneity of mixing and risk group replacement, which is very uncertain.

Nico Nagelkerke made the case for a number of other possible factors that could cause incidence declines if they are not coupled with behaviour change. One such example was that there is evidence of heterogeneity in susceptibility of HIV infection, which is largely excluded in all mathematical models and is assumed to be at a fixed rate. Nagelkerke provided an example of a recently reanalyzed data set from a cohort of sex workers in Nairobi, which showed that the risk of infection decreased by about 20% per year of exposure. If there is heterogeneity in susceptibility to this extent it could be possible that those who were going to get infected will have done so sooner and others who are less susceptible to the infection have remained uninfected, thus creating a fast rise in the incidence of a population, but also a rapid fall.

Another hypothesis investigated by **Kim Powers** is whether the lack of movement in sexual behavior indicators reported by UNAIDS may be because the measures used are insufficiently specific to adequately assess if there are changes. Examples of the indicators used are 'multiple partners in the last 12 months' or 'condom use at last high risk sex', which may not adequately capture subtleties of network mixing (including

contact patterns or mixing of risk groups) and condom use patterns that have implications for HIV transmission. Powers utilized different sexual behavior measures (with different degrees of detail and types of behavior reflected) found in country surveys to review behaviour change in countries that were reporting declines in incidence without coupled declines in behavioral indicators. The modelling exercise indicated that using these sexual behaviour indicators; very large reduction in the number of sexual partners would be needed. Using more detailed indicators, it was possible to reproduce incidence trends in Ethiopia, but implausible values for behaviour change were required. Therefore it is likely that behaviour change may not be sufficient to fully describe the incidence patterns.

The differences and difficulties with incorporating natural dynamics of the epidemic was further highlighted during a presentation by **Leigh Johnson**. Johnson's work in South Africa has aimed to establish how much of the decline in HIV incidence since 2000 has been a consequence of treatment and prevention programs. A dynamic modelling approach was used in which two models, STI/HIV interaction model and ASSA 2003, that define sexual risk behaviour in different ways were used to assess the impact of increased condom use (the one intervention that had a consistent national increase as found by literature reviews), ART and natural dynamics against national surveys.

In the models addition of ART accounted for only a very small-scale decrease in prevalence, whereas both models estimated that the decrease in prevalence was largely accounted for by increased condom use. The models did differ in the extent to which condom use accounted for the decrease in contrast with the effect of natural dynamics of the epidemic. This was largely a consequence of the heterogeneity incorporated in each model with STI/HIV interaction model, which has limited heterogeneity, estimating small changes in prevalence, but with ASSA 2003, which allows for extensive heterogeneity, estimating about a 17% change from natural dynamics without any interventions. Thus, the more heterogeneity you assume in your population, the lesser the effect interventions will have as you are assuming that high risk groups are not saturating and completing, but that lower risk groups mix or replace these individuals. This work therefore highlights the need for model comparison or further consideration about model structures when interpreting such modelling results.

Summary of Factors that could influence reported HIV incidence declines

Below is a complete list of possible factors that the meeting participants agreed could play some part in influencing reported incidence declines. At this stage it was agreed that no single factor alone would likely account for any possible misreporting of incidence and a number of additional investigative studies would need to be conducted to better understand.

Possible causes of poor inference from prevalence data

Data issues

- Non-random, non-response to DHS surveys for HIV tests: As more people are tested and begin to know their status could refusal for HIV tests with DHS surveys be increasing
- Over-estimated on-ART population?
- Low HIV test specificity in early data
- Shift in retesting policy when prevalence changes to lower value

Inappropriate inference methods

- Modelling at aggregated level: Rather than assessing incidence declines at either urban and rural or province level, as incidence of urban and rural populations may follow different patterns / trends that when averaged together a decline is exhibited
- Failing to fully capture between-model uncertainty
- Influence on epidemic trajectory through choice of priors on early prevalence

Wrong conceptualisation of HIV natural history

- Is assumed survival too long or has it changed? If survival is longer then you would have to assume larger reductions in incidence because fewer individuals would be dying
- Clade replacement

Wrong conceptualisation of programmes

- Are people on ART coming on later than we thought? This is combined with an assumption of who is eligible, but it does not tell us exactly who is on ART – are they people coming on treatment with very low CD4 counts. Assume that everyone who is on ART is less than age 50, whereas maybe that is also not true. This would have an effect on current incidence estimates, rather than historic reports of HIV incidence. Thinking about declines happening post peak.
- Wrong estimates about reduced infectiousness with ART

Demographic processes not captured

- Migration in/out of a small country: there may be differential migration of HIV+ve and HIV–ve people, for example if an individual has left their home country for work purposes and contracts HIV when living in the neighbouring country and returns home as they are no longer allowed to work
- Changes in population attending particular ANC
    - Ageing epidemic, changing fertility patterns, HIV sub-fertility
    - Attendance at ANC correlation with HIV changing over time via SES
    - Migrations of out (urban) clinic population to deep rural with AIDS
- Changes in sampling procedure within ANC
- Systematic change in characteristics of ANC sites in surveillance sample
- Bias towards including early ANC sites that have seen greatest (local) reduction

Reasons for lack of association with behaviour indicators

Behavioral indicators

- Natural epidemiological dynamics - incl. variation in susceptibility
- Viral evolution / clade replacement
- Behavioral indicators insufficiently specifc
- Biased reporting of sexual behaviours
- ART is responsible for most of the downturn in incidence.

Interpreting and communicating estimates

The overall conclusion from the meeting was that while there were many sources of uncertainty and potential biases in the estimation of HIV incidence trends, there was not substantial evidence to contradict the high-level conclusions reported by UNAIDS that adult HIV incidence has declined substantially over the past decade. It is important to remember that these are estimates and absolute confidence due to nuances surrounding the uncertainty and lack of data will naturally exist. The participants agreed that further understanding those issues would be useful in interpreting and communicating these declines in incidence in the future. It was agreed that the reasons for these declines were not well understood, except in a small minority of cases where substantial additional work has been undertaken (Thailand, Zimbabwe, South Africa). Without an understanding of the causes of the epidemiological changes it follows that it difficult to project future trends.

Future work

Following the meeting, the following areas were determined as priorities for further investigation by the HIV Modelling Consortium.

Research Question: How does the incorporation of heterogeneity of all kinds model projections for the impact of interventions

A model can be constructed that allows for variation between populations in their risk of infection or acquisition, that can be related to intrinsic fixed propensities on sexual behavior, behaviours that change as function of age, and intrinsic fixed host factors that affect susceptibility to infection. The model could be used to describe a dataset under different assumptions about each type of variation, and the fitted model be used to simulate the impact of interventions. In this way, it would be possible to understand how competing explanation for the spread of HIV in populations, and its potential decline, all of which involve an assumption for some kind of heterogeneity, can be traded-off against one another, and crucially, whether different formulations lead to significantly different predictions for the impact of interventions. This work would synergize with on-going work led by the consortium in model comparison.

Research Question: What are the possible effects of pooling ANC sites for a single epidemic trajectory and of the non-random selection of ANC sites?

This analysis would have three parts:

1. Describe epidemic trajectory with reference to when clinic entered surveillance system. This would establish whether there is an important relationship between the epidemic trends that are observed a particular site and the timing of that site's entry into the surveillance system.

2. Sort ANC clinics ("by hand") into different "bundles" reflecting distinct incidence trends, and compare versus pooled epidemic trajectory. This will establish whether national epidemic trend might be distorted through the existing constraint of a uniform epidemic trend in all locations in a country.

3. In response to findings from the first two parts, possible approaches to handling these challenges should be proposed. For instance, would a random-effect on clinic start time reduce confounding, or would further geographic stratification of the ANC sites lead to different results?

Research Questions: Is the Trend in Prevalence Among ANC attendees an Unbiased Estimates of the True HIV Prevalence trend.

As described above, the estimations of trends in HIV prevalence is most strongly determined by the ANC data and much previous work has investigated factors that could lead to biases in that trend. However, the following further analyses will be useful in the continued assessment of the use of ANC data:

1) Comparison of the trend in ANC prevalence data and the estimated prevalence among pregnant women in the DHS surveys. The trends in these two estimates should be the same, but differences may indicate evolving biases in one or both data sources.

2) Consider all the potential biases operating on the women attending ANC in one model simultaneously. This would include changing fertility patterns, attendance at ANC patterns by age, parity and socio-economic status and other correlates of HIV infection and migration. The model could also investigate the influence of clinic excluding known HIV-infected women from testing and associated records.

Research Question: Can the large observed declines in HIV prevalence be reconciled with apparently modest changes in behavior in a network model?

Through a previous work package project, Drs Marie-Claude Boily and Romain Silhol at Imperial College London, are already working to assess how increasingly complex patterns of partnership formation and

dissolution alter estimation of intervention impact at different epidemic stages. The exercise will review the effect of these mixing patterns in different model structures (deterministic and individual-based models) and also assess the influence of ignoring sex and age structures. In part, this work will directly respond to this question.

Output: Work is ongoing and will be presented at Epidemics in November 2013, following which one or two papers will be developed for publication.

Research Question: Are estimates of epidemic trends improved by explicitly including age-structure in the model?

This exercise will aim to highlight the merits of using age-structured models in the UNAIDS estimation process. One rationale for including age-structure in the model to bit is that this would allow age-structured prevalence data and potentially mortality data, (and in the future other sources of information). Potential problems would include the attendant complexity in the model that this would require, which could lead to increased computational time, for little benefit.

It was proposed that researchers be invited to develop new structured model for EPP (The UNAIDS estimation model). Groups would be convened after one year so that results can be compared and the case for revisiting the EPP model assessed. Throughout, the modeling consortium secretariat would assist all groups in the development process. Groups would be asked to provide mode results a pre-determined set of countries that typify the data availability in countries for which estimates would be derived.

Participating groups may also consider: In addition to the above the following points could also be explored within this exercise:

- ANC surveillance system may be replaced with reporting from PMTCT clinics, providing a greater amount of data with better geographic coverage, but with only consenting women receiving the test.
- There is move to generating estimates at sub-national levels, meaning that the data available to fit each model is reduced.

Output: To demonstrate if it is possible and worthwhile to incorporate age structure into models and if it can be done so for a number of countries and would provide better estimates.

HIV Modelling Consortium

Wednesday 18 September – Day 1

Time	Session	Speaker	Location
09:00	Welcome coffee	-	Windsor Suite Foyer
09:30	**Welcome and introduction** • Overview of meeting schedule and aims *(10 mins)*	Tim Hallett	Windsor Suite

09:40	**Session 1: Why we need to better understand the UNAIDS incidence estimates** *(Chair: Tim Hallett)*
	• Review of the latest UNAIDS estimates – case studies of countries with largest declines in incidence *(15 mins)*
	• Perspective of donors *(20 mins)*
	• Estimating HIV incidence at a country level: an introduction to the UNAIDS methodology *(15 mins)*
	• Understanding EPP: *(5 mins)*
	  ○ Technical specification of the model: underlying model, fitting, calibration, ART correction and assumptions on survival *(25 mins)*
	  ○ Statistical approach: incidence model and it fits to data (*10 mins)*
		John Stover
		Nicole Fraser
		Mary Mahy
		Tim Brown
		Robert Puckett
		Tim Brown
			Windsor Suite

11:10	Coffee break	-	Windsor Suite Foyer
11:40	**Session 1 (continued): Group discussion** *(Chair: Tim Hallett)* • What are the potential sources of bias for downward trends in HIV incidence? *(30 mins)*	All	Windsor Suite
12:10	Lunch	-	Fiamma Restaurant & Bar
13:25	**Introduction** • The question posed by Steering Committee *(10 mins)*	Geoff Garnett	Windsor Suite
13:35	**Session 2: Hypotheses for reasons for potential poor inference about incidence from HIV prevalence data** *(Chair: Josh Salomon)* • HIV status and HIV test refusal: review of levels of non-response in DHS surveys and evidence for non-randomness *(20 mins)* • What are the implications of biases in DHS due to non-random non-response? *(20 mins)* • What are the implications of biases in ANC due changing age-patterns in the ART era *(20 mins)* • What are the implications of not incorporating the age at seroconversion into estimates? *(10 mins)*	Mark McGovern Kim Powers Kim Powers Kim Powers	Windsor Suite
14:45	Coffee break	-	Windsor Suite Foyer
15:15	**Session 2 (continued)** *(Chair: Josh Salomon)* • Comparison of HIV prevalence trends in UNAIDS estimates and serial DHS surveys *(10 mins)* • Potential biases in recent HIV incidence estimates due to adjustments for ART *(15 mins)*	Jeff Eaton Jeff Eaton	Windsor Suite
15:40	**Day one summary** • Final remarks and summary of day one discussions *(20 mins)*	Josh Salomon / Tim Hallett	Windsor Suite
16:00	Meeting close	-	-
17:00	>> Walk to St Mary's Campus for Leigh Johnson seminar	-	Meet at reception
17:30	Understanding recent changes in HIV incidence and AIDS mortality in South Africa: insights from mathematical modelling	Leigh Johnson	Rothschild Lecture Theatre
19:00	Dinner at Frontline Club	-	Frontline Club

HIV Modelling Consortium

Thursday 19 September - Day 2

Time	Session	Speaker	Location
09:00	Welcome coffee	-	Windsor Suite Foyer
09:30	• Overview of meeting schedule *(15 mins)*	Tim Hallett	Windsor Suite
09:45	**Session 3: What could explain a lack of association between estimated incidence and individuals' risk of HIV infection? Factors disconnecting behaviours from prevalence trends** *(Chair: Jeff Eaton)* • Are observed incidence declines consistent with behavior change – country case studies *(20 mins)* • Natural declines in HIV prevalence in maturing epidemics *(20 mins)* • Other potential explanations for changes in HIV incidence if it is not associated with sexual behaviour indicators *(20 mins)*	Laith Abu-Raddad Tim Hallett Nico Nagelkerke	Windsor Suite
10:45	Coffee Break	-	Windsor Suite Foyer
11:15	**Session 3 (continued)** *(Chair: Jeff Eaton)* • Should we expect UNAIDS behavioural indicators to predict changes in incidence? *(20 mins)* • Natural dynamics and accounting for biases in changes in condom use *(20 mins)* • Could ART explain incidence declines in some settings already? *(10 mins)*	Kim Powers Leigh Johnson Jeff Eaton	
12:05	Lunch	-	Fiamma Restaurant & Bar

13:15	**Session 4: Group discussion to answer questions 2 and 3**
	Part A: Recommendations for confidence and messaging around UNAIDS estimates *(Chairs: Tim Hallett and Jeff Eaton)*
	• What is the most appropriate messaging around high-level conclusions from current results in UNAIDS estimates:
	  ○ HIV incidence has declined globally and in sub-Saharan Africa.
	  ○ Behaviour change has been responsible for declines in incidence.
	  ○ The international response has catalyzed these changes.
	• Is additional caution merited in generalized epidemic settings where incidence is estimated to have declined but beahvioural indicators have not changed, or are there sufficient explanations for these conflicting trends?
		All	Windsor Suite

14:45	Coffee break	-	Windsor Suite Foyer
15:15	**Session 4: Group discussion to fulfill outcomes 1 and 2** **Part B: Proposal for research agenda** *(Chairs: Tim Hallett and Jeff Eaton)* • What hypotheses discussed in Session 1 are high priority for additional research? • What further research is necessary to fully understand potential for biases in surveillance/estimation approach? • What developments - short, and medium/long term - could strengthen the ability of the surveillance/estimation approach to make statements about changes in incidence and their causes?	All	Windsor Suite
16:45	**Day two summary** • Final remarks and summary of meeting discussions *(15 mins)*	Tim Hallett	Windsor Suite
17:00	Meeting close	-	-

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